EXHIBIT D

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF MICHIGAN
(SOUTHERN DIVISION)

IMRA AMERICA, INC., a Michigan corporation, Plaintiff/Counterclaim Defendant, v. IPG PHOTONICS CORPORATION, a Delaware corporation, Defendant/Counterclaim Plaintiff.	Case No.: 2:06-15139 Judge: Hon. Anna Diggs Taylor Magistrate: Hon. Mona K. Majzoub

EXPERT REPORT OF PHILIP H. BUCKSBAUM, Ph.D.

On the other hand, at first blush the '630 patent appears to quantify "substantially in the fundamental mode" as having an M^2-value of the less than 10. It states:

> "It is instructive to relate N to the M^2-value that is typically used to characterize the quality of near-diffraction-limited optical beams. It may be shown that $N \approx \sqrt{M^2}$. According to the present invention, a low level of mode-coupling is desirable, so that the amplified beam provided at the output of the MM fiber amplifier 12 is substantially in the fundamental mode. Accordingly, an M^2-value less than 10 is desirable, with an M^2-value less than 4 being preferable, and an M^2-value less than 2 being more preferable."[14]

Claims 46-48 of the '630 patent, which depend from claim 1, likewise recite an M^2-value for the output of the multi-mode fiber amplifier of less than 10, 4, and 2, respectively. This is nonsensical to me, and also to a person of ordinary skill in the art ("POSITA"), especially in view of how the '630 patent otherwise uses a very narrow meaning for this term.

To illustrate why an output beam having an M^2 as high as 10 cannot be "substantially in the fundamental mode," I note that M^2 is the ratio of the beam product parameter for a real beam to that of an ideal, diffraction-limited Gaussian beam.[15] A POSITA would simply not consider a beam with beam parameter product *10 times larger* than that for an ideal diffraction-limited Gaussian beam (i.e., the fundamental mode) as "substantially in the fundamental mode." For example, the second Siegman paper provides an example of a Gaussian beam composed entirely of a mixture of higher order modes, including 45% of the LG_{01} mode, 17% of the LG_{10} mode, 20% of the LG_{11}* mode, 11.5% of the LG_{20} mode, and 6% of the LG_{21}* mode. The beam is shown in Figure 1(a) of the second Siegman paper, and has an M^2 value of about 3.1, and yet it "contains no TEM_{00} mode component [i.e., the fundamental mode] at all."[16] Thus, even beams with M^2-values as small as 3.1 may have *no* intensity in the fundamental mode, let alone be "substantially in the fundamental mode" as required by the claims. Similarly, as noted above,

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[14] The '630 patent at col. 6, lines 3-12.

[15] See, e.g., A.E. Siegman, "New Developments in Laser Resonators" in SPIE Vol. 1224: 1-14 (1990) (hereinafter the "first Siegman paper") at page 7; A.E. Siegman, "Defining, measuring and optimizing laser beam quality" in SPIE Vol. 1868: 1-12 (1990) (hereinafter the "second Siegman paper") at pp. 4-5; and the LFW paper at pp. 180-182.

[16] The second Siegman paper at p. 2.

the LFW paper shows that only beams with an M^2 of less than 1.2 is an effectively fundamental mode beam.

This inconsistency stems from an error in the formula used to calculate the numerical M^2-values of 10, 4, and 2 recited in the specification and claims. For example, the '630 patent states "[i]t may be shown that $N \approx \sqrt{M^2}$."[17] This is incorrect, and contrary to the conventional definition for M^2. For example, with respect to a Hermite-Gaussian representation of spatial modes, for equal excitation of N modes, M^2 varies as the *square root* of N, not as the *square* of N as incorrectly stated in the '630 patent.[18] This error is repeated in M.E. Fermann, "Single-mode excitation of multimode fibers with ultrashort pulses," Optics Letters 23(1): 52-54 (1998) (hereinafter the "Fermann paper"), which states that the launching efficiency into a fiber, η, is related to M^2 according to $1/\eta \approx \sqrt{M^2}$.[19] The '630 patent states that $\eta \approx 1/N$,[20] and combining these equations again yields the erroneous result $N \approx \sqrt{M^2}$.

As a result, the erroneous M^2 defined by the equation $N \approx \sqrt{M^2}$ in the '630 patent corresponds to the conventional M^2 to the fourth power. In other words, an M^2 less than 10 as defined by the equation $N \approx \sqrt{M^2}$ in the '630 patent corresponds to a conventional M^2 that is less than 1.78 (i.e., the fourth root of 10). While this conversion makes the numerical values set forth in the '630 patent somewhat more intelligible, the equation still contradicts the assertion in the specification that the patent is using the conventional description of M^2, since an M^2 of 1.78 is well above the 1.2 value that I and others in this field would consider the upper limit for a substantially diffraction limited output beam. It also cannot be squared with the patent's criticism of Griebner, with his M^2 of 1.5, as having "poor beam quality."

6. Furthermore, because I understand the limitation "substantially in the fundamental mode" from claim 1 as requiring an M^2-value of less than 1.2, I conclude that claims 46-48,

[17] The '630 patent at col. 7, lines 5-6.

[18] The first Siegman paper at page 9. Specifically, in the first equation on page 9, set the upper limits for the sums over n and m to $\sqrt{N}-1$ so that the total number of modes is N, and set the coefficients equal to one another, specifically $\tilde{C}_{nm} = 1/\sqrt{N}$, so that $\sum_{nm}\left|\tilde{C}_{nm}\right|^2 = 1$ as required in the first paragraph of p. 9.

[19] The Fermann paper, p. 52, right column.

[20] The '630 patent at col. 6, line 48.

which require an M^2-value of less than 10, 4, and 2, respectively, are invalid because they do not further limit the scope of claim 1.

VI. Comparison of Prior Art to Asserted Claims

1. I will now address the validity of each of the asserted claims in this lawsuit with respect to the prior art.

2. A detailed comparison of the asserted claims of the '630 patent against the relevant prior art is made in the Exhibits attached as Appendix C to this report. In the Exhibits, I sometimes indicate that certain features of the asserted claims would have been obvious to a person of ordinary skill in the art at the time of the alleged invention, or that a person of ordinary skill in the art at the time of the alleged invention would have been motivated to combine certain prior art references. In making these statements, I took into consideration the prior art references' explicit and implicit teachings, the prior art as a whole, the general knowledge of a person of ordinary skill in the art, and/or the nature of the problem to be solved. I note that IMRA has not identified any alleged secondary factors of non-obviousness or any nexus between any such factors and the claimed invention.

3. Further, to the extent that any reference that I have described in Appendix C as anticipatory is found to not disclose a particular limitation of the asserted claims, it is my opinion that all of the asserted claims would still have been obvious to a person of ordinary skill in the art at the time of the alleged invention in light of these references. For example, any reference described in Appendix C could have been combined with other references found in Appendix C to provide the missing limitation(s), at least for the reasons discussed above. The references in Appendix C are directed to the same field of endeavor, namely, amplification of optical pulses in multimode fibers.

4. In the following prior art analysis, I will occasionally consider arguments in the alternative corresponding to what I think is the correct claim construction and how I currently understand the interpretation from IMRA.

The Digonnet Thesis

IX. Concluding Statements

1. This report contains a summary of the opinions I have reached to date. To the extent permissible and/or required under controlling legal authority, I reserve the right to supplement, amplify on, and/or amend the opinions expressed herein, including in response to positions taken by IMRA, or any experts retained by IMRA. In connection with my anticipated trial testimony in this action, I may use as exhibits various documents produced, or testimony given, in this litigation which refer or relate to the matters set forth in this report. In addition, before my trial testimony, I may create certain demonstrative exhibits to be used at trial. Finally, I reserve the right to demonstrate for the Court and jury the operation of any and all of the prior art references or systems discussed in this report.

Executed this 21st day of December, 2007.

By: Philip H. Bucksbaum

Philip H. Bucksbaum